

Claims

- [c1] 1. A method of controlling exhaust emission oxides of nitrogen (NO_x) from an internal combustion engine (ICE), the method comprising:
determining when an engine speed is below a first pre-determined level; and
controlling an oxygen displacement valve (ODV) such that at least a portion of exhaust gas generated by the ICE is directed into an intake air flow of the ICE.
- [c2] 2. The method set forth in claim 1 wherein the method is performed during a restart operation of a hybrid electric vehicle (HEV).
- [c3] 3. The method set forth in claim 1 wherein the method is performed during a deceleration operation of a conventional powertrain vehicle.
- [c4] 4. The method set forth in claim 1 further comprising fully closing an engine throttle.
- [c5] 5. The method set forth in claim 1 further comprising providing a rich air to fuel ratio (AFR) to the ICE for a first predetermined period of time.

- [c6] 6. The method set forth in claim 5 further comprising stopping delivery of fuel to the engine.
- [c7] 7. The method set forth in claim 1 further comprising controlling the ODV valve such that no exhaust gas is directed into the intake air flow when a decision is made to restart the engine.
- [c8] 8. The method set forth in claim 7 further comprising spinning up the engine up to a starting speed.
- [c9] 9. The method set forth in claim 8 further comprising providing a rich AFR to the engine for a second predetermined period of time.
- [c10] 10. The method set forth in claim 9 wherein the rich AFR is provided by controlling an evaporative control valve such that at least a portion of fuel evaporative vapors are directed to the intake air flow.
- [c11] 11. The method set forth in claim 7 further comprising opening a throttle.
- [c12] 12. A system for controlling exhaust emission oxides of nitrogen (NO_x) from an internal combustion engine (ICE), the system comprising:
sensors for determining operating conditions of the ICE;
and

a controller for determining when an engine speed is below a first predetermined level, and controlling an oxygen displacement valve (ODV) such that at least a portion of exhaust gas generated by the ICE is directed into an intake air flow of the ICE.

[c13] 13. The system set forth in claim 12 wherein the ODV is controlled during a restart operation of a hybrid electric vehicle (HEV).

[c14] 14. The system set forth in claim 12 wherein the ODV is controlled during a deceleration operation of a conventional powertrain vehicle.

[c15] 15. The system set forth in claim 12 wherein the controller further fully closes an engine throttle.

[c16] 16. The system set forth in claim 12 wherein the controller further provides a rich air to fuel ratio (AFR) to the ICE for a first predetermined period of time.

[c17] 17. The system set forth in claim 16 wherein the rich AFR is provided by controlling an evaporative control valve such that at least a portion of fuel evaporative vapors are directed to the intake air flow.

[c18] 18. The system set forth in claim 16 wherein the controller stops delivery of fuel to the engine.

- [c19] 19. The system set forth in claim 12 wherein the controller operates the ODV valve such that no exhaust gas is directed into the intake air flow when a decision is made to restart the engine.
- [c20] 20. The system set forth in claim 19 wherein the controller controls spinning up the engine up to a starting speed.
- [c21] 21. The system set forth in claim 20 wherein the controller provides a rich AFR to the engine for a second predetermined period of time.
- [c22] 22. The system set forth in claim 19 wherein the controller opens a throttle.
- [c23] 23. A method of controlling exhaust emission oxides of nitrogen (NO_x) from a variable valve internal combustion engine (ICE), the method comprising:
determining when an engine speed is below a first predetermined level; and
controlling the variable valves such that at least a portion of exhaust gas generated by the ICE is directed into an intake air flow of the ICE.
- [c24] 24. The method set forth in claim 23 further including the step of controlling the variable valves such that no

exhaust gas is directed into the intake air flow when a decision is made to restart the ICE.